

Remarks

Status of application

Claims 1-68 are pending in the subject application. The claims stand rejected over the prior art. After review of the amendments to the claims and Applicants' remarks below, the Examiner's re-examination and reconsideration of the claims are respectfully requested.

The invention

A digital imaging system is described that provides techniques for reducing the amount of processing power required by a given digital camera device and for reducing the bandwidth required for transmitting image information to a target platform. The system defers and/or distributes the processing between the digital imager (i.e., digital camera itself) and the target platform that the digital imager will ultimately be connected to. In this manner, the system is able to decrease the actual computation that occurs at the digital imager. Instead, the system only performs a partial computation at the digital imager device and completes the computation somewhere else, such as at a target computing device (e.g., desktop computer) where time and size are not an issue (relative to the imager). By deferring resource-intensive computations, the present invention substantially reduces the processor requirements and concomitant battery requirements for digital cameras. Further, by adopting an image strategy optimized for compression (compressed luminosity record), the present invention decreases the bandwidth requirements for transmitting images, thereby facilitating the wireless transmission of digital camera images.

Prior art rejection

A. First Section 103 rejection: Rabbani, Wang, and Bauchspies

Claims 1, 3-15, 18-21, 23-34, and 38-40 stand rejected under 35 U.S.C.

Section 103(a) as being unpatentable over Rabbani et al. (U.S. Pat. No. 5,412,427, hereinafter "Rabbani") in view of Wang et al. (U.S. Pat. No. 5,682,152, hereinafter "Wang") further in

view of Bauchspies (U.S. Pat. No. 6,008,847, hereinafter "Bauchspies"). The Examiner's rejection of claim 1 is representative of the rejection:

Regarding claim 1, Rabbani et al. disclose an electronic camera utilizing image compression feedback for improved color processing, comprising recording luminosity information at a first device (the green and color difference signals are stored in storage module 28 of the digital camera (first device), figure 7, column 6, lines 5-20); generating compressed luminosity information at the first device (figures 5-7, column 5, line 37 through column 6, line 20); transmitting said compressed luminosity information to a second device (the compressed signal could be downloaded to the personal computer (second device, column 6, lines 15-20). Rabbani et al. fail to specifically disclose applying a wavelet transform, quantization, and compression to the luminosity information.

(Examiner's Action, paragraph 2)

As noted above by the Examiner, Rabbani includes no teaching regarding the claim limitations of wavelet transform, quantization, and compression to the luminosity information. Next, the Examiner turns to Wang for the teaching of a wavelet transform algorithm and a quantization stage (column 1, lines 45-65), with the Examiner contending that the combination would have been obvious. However, the Examiner notes that the combination of Rabbani and Wang do not disclose "restoring said luminosity information at the second device and converting said luminosity information at the second device into a color image." Nevertheless, the Examiner contends that this could have been provided by Bauchspies, which teaches "a temporal compression and decompression system in which the compressed video stream 105 is transmitted over the telephone line to a remote computer 92 (target device) for subsequent temporal decompression 106 (restoring, figure 2, column 5, lines 40-44)." The Examiner raises similar objections to independent claim 21. By implication, the dependent claims of both are similarly rejected.

Although the originally-filed claims are believed to distinguish over the art, the claims have been amended in an effort to further distinguish over the art and facilitate prosecution of the present application. Under Section 103, the combined prior art references must teach or suggest all the claim limitations. (See e.g., MPEP 2142). The references cited

by the Examiner fail to meet these conditions. Accordingly, the amended claims distinguish over the references.

Amended claim 1 now includes the following claim limitations (shown in amended form):

recording luminosity information at a first device, for
representing an image that has been digitally captured at the first device;
without performing color interpolation at the first device,
generating compressed luminosity information at the first device by applying a
wavelet transform, quantization, and compression to the luminosity
information;
transmitting said compressed luminosity information to a
second device;
restoring said luminosity information from said compressed
luminosity information at the second device; and
converting said luminosity information at the second device
into a color image, including performing color interpolation at the second
device.

(Independent claim 21 has been similarly amended.) As shown by the above amendment to claim 1, the claim now makes it explicit that the claimed approach includes deferring the interpolation process until after the image data is transferred from the first device (i.e., the source device, such as a small digital camera) to the second device (e.g., a server computer). Using this approach of deferring color processing/interpolation, a digital camera may forego resource requirements (e.g., processor and battery resources) that would otherwise be required for performing the traditional device-side processing, such as described by Rabanni. Further, the deferral of color processing/interpolation at the first device decreases the amount of data generated at the first device that has to be transmitted, thereby making the approach particularly advantageous for wireless transmission of images (e.g., from the first device to the second device). None of the cited references teach or suggest these limitations.

Rabanni, for example, describes a digital camera (10) that includes a color interpolator (24) that functions “to provide the missing green values for those pixel locations that contain a red (R) or blue (B) pixel value.” (See, e.g., Rabanni column 2, lines 28-51, and Fig. 3.) The other designs described by Rabanni (e.g., Rabanni’s Figs. 5 and 6) carry over

this basic design (of color interpolation at the digital camera). For example, Rabanni states at column 4, lines 11-19:

This [Rabanni's] invention aims to improve the image quality of an imaging system of the type shown in FIG. 1, which comprises a color transformation stage followed by lossy image compression and decompression stages, and a color transformation decoding stage. The improvement is obtained as shown in FIG. 5 by providing a feedback from the output of the compression stage 16 through a feedback decompression stage 30 into the color transformation stage 14.

Thus, as illustrated above and shown in Rabanni's figures, Rabanni's approach preserves the conventional architecture/approach of having the camera devices perform color processing.

Neither Wang nor Bauchspies overcomes this deficiency of Rabanni. Wang, for instance, basically describes a compression algorithm implemented as "method and apparatus for adaptive bit allocation and hybrid lossless entropy encoding in a lossy compression system." (Wang at column 1, lines 45-47.) The preferred embodiment of Wang's compression algorithm includes three components, as described by Wang at column 1, lines 49-53. A detailed review of Wang reveals no discussion about how Wang's approach could be used to defer color interpolation so that color interpolation is performed at a subsequent (second) device, as required by Applicants' claims.

Bauchspies is equally silent in this regard. Bauchspies describes a temporal compression and decompression system for color video. At the outset, Bauchspies states, "A video stream with red, green and blue pixel element values is input to a first computer." (See, e.g., Bauchspies' Abstract.) As best as Bauchspies is understood, the Bauchspies approach deals with a conventional video stream (i.e., one in which color interpolation is performed at the camera). In any event, as with Wang, a detailed review of Bauchspies reveals no discussion about how Bauchspies' approach could be used to defer color interpolation so that color interpolation is performed at a subsequent (second) device.

A claim is obvious under Section 103 only if each and every element as set forth in the claim is found, either expressly or inherently, in the combined prior art references. As Rabbani, Wang, and Bauchspies fail to teach each and every element set forth

in claim 1 (and corresponding independent claim 21), as well as the other claims dependent from claim 1 (and corresponding dependent claims of claim 21), the references fail to establish obviousness of the claimed invention under Section 103.

B. Second Section 103 rejection: Rabbani, Wang, Bauchspies, and Fukuoka
Claims 2, 16-17, 22, and 35-37 stand rejected under 35 U.S.C. Section 103(a) as being unpatentable over Rabbani et al. (above) in view of Wang et al. (above) and Bauchspies (above) further in view of Fukuoka (U.S. Pat. No. 5,754,227, hereinafter "Fukuoka"). The claims, particularly in view of amendments to parent claims 1 and 21, distinguished over the art.

In this rejection, the Examiner acknowledges that Rabbani, Wang, and Bauchspies do not provide any disclosure related to Applicants' wireless transmission claim limitation. Nevertheless, the Examiner contends that Fukuoka teaches this claim limitation. The claims are believed to be allowable for at least the reasons cited above pertaining to Rabbani, Wang, and Bauchspies (for the Section 103 rejection of parent claims 1 and 21). The claims are also believed to be allowable for the following additional reasons.

The rejected claims add the additional limitation that the transmitting step, which transmits compressed luminosity information to a second device, occurs wirelessly. As set forth in the now-amended parent claim 1, the information that is transmitted is compressed luminosity information that is generated without performing color interpolation at the first device. The transmitted information therefore, at this point, has not yet been converted into a color image (since color interpolation has been deferred until arrival of the information at the second device).

For this rejection, the Examiner states that Fukuoka teaches that "images captured by the camera can be transferred through the I/O card 15 which functions as modem connected to an on-line service such as American On Line (column 3, lines 50-60)." Further review of Fukuoka reveals that the Fukuoka camera does in fact perform color processing at the camera (see, e.g., Fukuoka at column 5, lines 9-29). Given that explicit teaching, Fukuoka clearly teaches away from Applicants' approach of foregoing camera-side color

processing and instead simply transmitting information which has yet to undergo color processing.

Particularly in view of the above-described amendment to base claims 1 and 21, the rejected claims 2, 16-17, 22, and 35-37 now include the explicit limitation that the color processing occurs, not at the first device (camera) itself, but at a second device (e.g., a server computer) to which the information has been transferred. The claim language, taken as a whole, requires the transmission of a partially-processed image to a second device (e.g., a server) that, in turn, completes the processing. Note particularly at this point that the information transmitted is not suitable for display to a user as a color image since interpolation of color information has yet to occur. (A camera-side monochromatic facsimile may be generated for preview/post-view purposes, if desired.) Since the claims include claim limitations that are not described by the combined references, by virtue of the amendment to base claims 1 and 21 (as well as other limitations already present in the claims), it is respectfully submitted that the claims distinguish over the references.

C. Third Section 103 rejection: Rabbani and Bauchspies

Claim 41, 43-44, 47-54, and 58-66 stand rejected under 35 U.S.C. Section 103(a) as being unpatentable over Rabbani et al. (above) in view of Bauchspies (above). Independent claim 41 is a system claim that includes claim limitations analogous to previously-discussed independent claims 1 and 21. For this rejection, the Examiner repeats his basic position that Rabbani teaches the bulk of Applicants' claim limitations, except in this rejection the Examiner adds Bauchspies for the teaching of a decompression module. Although the originally-filed claims are believed to distinguish over the combination of Rabbani with Bauchspies, the claims that nevertheless been amended in an effort to expedite prosecution of the present application.

Amended claim 41 now includes the following claim limitations (shown in amended form):

a compressor module for compressing said luminosity information, for generating compressed luminosity information at the imager without having performed color processing;

That color processing occurs at the target device is made clear by the claim's last limitation:

a decompression module for **decompressing** said compressed luminosity information **at the target device, whereupon said sensor information** may thereafter be **processed into a color image**.
(emphasis added)

The claims, particularly in view of the amendment to parent claim 41, distinguished over the art.

Rabbani does not provide any teaching analogous to Applicants' deferral of color processing (e.g., deferral of color interpolation). Since Bauchspies does not remedy this deficiency of Rabbani (as well as other deficiencies), the combined references do not teach or suggest all of the claim limitations of Applicants amended claim 41 (and its dependents) and thus do not establish prima facie obviousness under Section 103.

D. Fourth Section 103 rejection: Rabbani, Bauchspies, and Fukuoka

Claims 42 and 55-57 stand rejected under 35 U.S.C. Section 103(a) as being unpatentable over Rabbani (above) in view of Bauchspies (above) further in view of Fukuoka (above). Here, the Examiner adds Fukuoka in the same manner as was done for the rejection of claims 2, 16-17, 22, and 35-37 (i.e., for the position that it teaches Applicants' wireless transmission claim limitations). The claims are believed to be allowable for at least the reasons cited above pertaining to Rabbani and Bauchspies (for the First, Second, and Third Section 103 rejections above) -- that is, that those references fail to teach or suggest Applicants' approach of foregoing color processing at the camera or imager device.

The claims are also believed to be allowable for the reasons cited above pertaining to Fukuoka in the Second Section 103 rejection. Since color interpolation has been deferred until arrival of the information at a target device, the wireless transmission that

occurs in these rejected claims is the transmission of information that has not yet been converted into a color image. To the point, parent claim 41 (which these claims depend from) has been amended to make it clear that the information that is transmitted is compressed luminosity information that has not yet been color processed. Since the combined references do not teach or suggest all of the claim limitations of Applicants' claim 41 (and, by implication, its dependents), the references do not establish prima facie obviousness under Section 103.

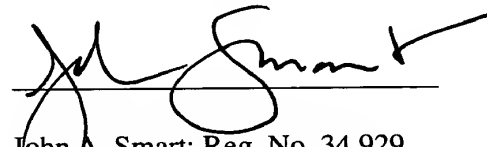
Conclusion

In view of the foregoing remarks and the amendment to the claims, it is believed that all claims are now in condition for allowance. Hence, it is respectfully requested that the application be passed to issue at an early date.

Appended herewith is an attachment captioned "Version with markings to show changes made" presenting a marked-up version of the changes made to the application by the current amendment. An attachment captioned "Clean-copy Version of Claims" showing all remaining claims, in clean form, is also included. If for any reason the Examiner feels that a telephone conference would in any way expedite prosecution of the subject application, the Examiner is invited to telephone the undersigned at (408) 395-8819.

Respectfully submitted,

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Version with markings to show changes made

In the specification,

Marked-up version of the replacement paragraph(s)/section(s), pursuant to 37 CFR 1.121(b)(1)(iii):

The specification has not been amended.

In the claims,

Marked-up version of the amended claims, pursuant to 37 CFR 1.121(c)(1)(ii):

Claim 1 has been amended as follows:

1. (Amended) In a digital imaging system, a method for distributed digital image processing, the method comprising:
 - recording luminosity information at a first device, for representing an image that has been digitally captured at the first device;
 - without performing color interpolation at the first device, generating compressed luminosity information at the first device by applying a wavelet transform, quantization, and compression to the luminosity information;
 - transmitting said compressed luminosity information to a second device;
 - restoring said luminosity information from said compressed luminosity information at the second device; and
 - converting said luminosity information at the second device into a color image, including performing color interpolation at the second device.

Claim 21 has been amended as follows:

21. (Amended) In a digital imaging system, a method for deferring digital image processing, the method comprising:

recording sensor information from an image sensor at a first device, for representing an image that has been recorded at the image sensor of the first device;

compressing said sensor information prior to color processing, for generating compressed sensor information at the first device;

without having performed color processing at the first device, transmitting said compressed sensor information to a second device; and

decompressing said compressed sensor information at the second device, whereupon said sensor information may thereafter be processed into a color image.

Claim 41 has been amended as follows:

41. (Amended) An imaging system providing deferred image processing, the system comprising:

an imager having a sensor for recording luminosity information for a visual image captured by the imager, said luminosity information comprising luminosity values recorded by the sensor;

a compressor module for compressing said luminosity information, for generating compressed luminosity information at the imager without having performed color processing;

a communication link for transmitting said compressed luminosity information to a target device; and

a decompression module for decompressing said compressed luminosity information at the target device, whereupon said sensor information may thereafter be processed into a color image.